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For SEM-2 (M.Sc.)
MBOT CC-2
UNIT II

BACTERIA

① Bacteria are simplest cellular organisms. They are prokaryotes.

② The bacterium was observed for the first time by Antony Von Leeuwenhoek (1675) from his own teeth scum. It was named animalcules.

③ Christian G. Ehrenberg named such structures as bacteria (Greek = Small sticks) in 1928.

④ Louis Pasteur (1864) ~~reported~~ and Robert Koch (1875) reported their ability to cause diseases.

⑤ The bacteria are placed in a single class SCHIZOMYCETES and classified into 10 orders according to the Bergey's Manual of Determinative Biology.

Bacteria may be characterized by having following characteristics —

(i) They contain chromosome (DNA without histone) which are not surrounded by any definite membrane (or double the nuclear structure).

(ii) The cell wall is made up of mucopeptide rather than Cellulose.

(iii) Absence of membrane bound metabolically functional organelles like Mitochondria, Chloroplast, Golgi bodies, and Lysosomes etc.

(iv) Ribsomes are of 70's type and not 80's type.

(v) They lack 9+2 structure of flagellum.

(vi) Extra-chromosomal genetic element in the form of a piece of DNA is present in some bacteria.

(vii) ~~Mesosomes~~ Mesosomes and photosynthetic lamellae are present in some forms.

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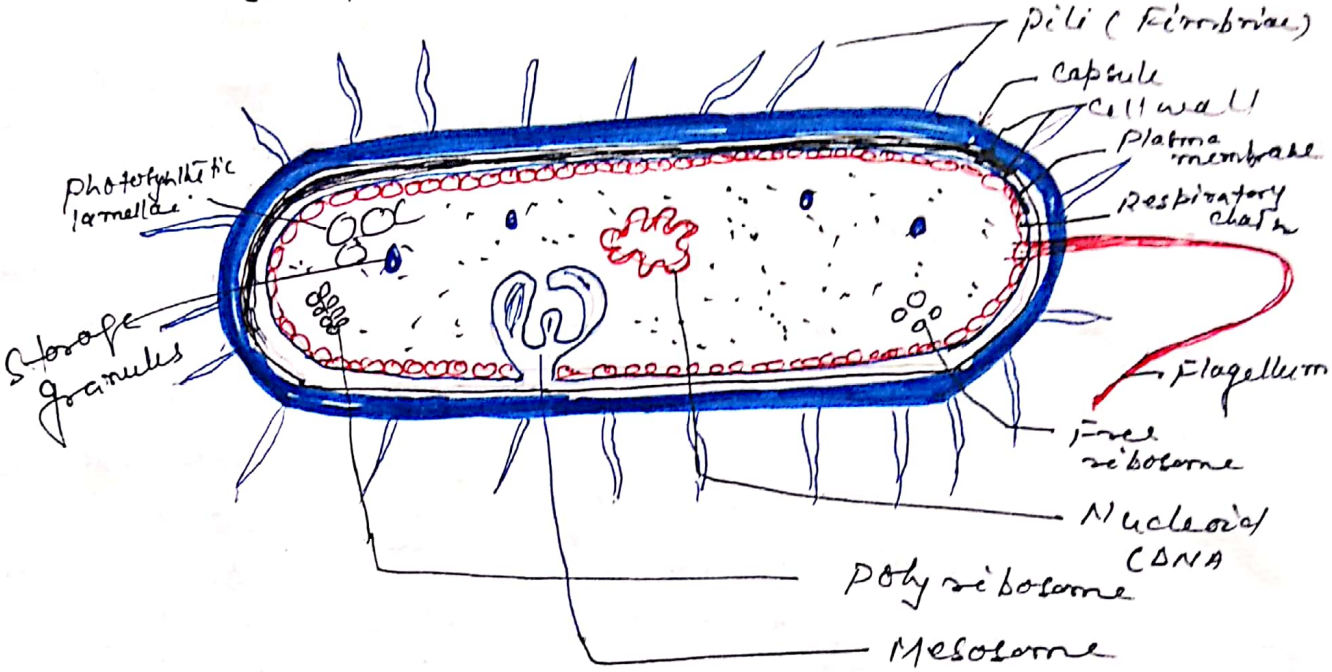
THE STRUCTURE OF BACTERIA

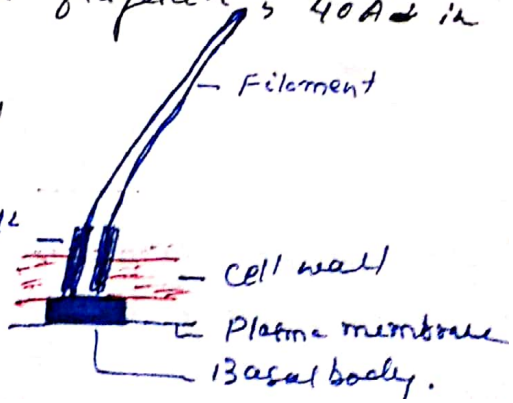
The bacterial structure can be studied under the following heads—

(i) Surface appendages - flagella, pili
(ii) Surface adherents - Capsule and Slime layers
(iii) Cell wall & Cell membrane
(iv) Cytoplasm & organelles - Mesosome, ribosome, reserve food, Chromatophore, Nucleoid,
(v) Special structures - endospores, stalks.



(i) Surface appendages :

(a) Flagellae - They are slender, long unbranched structure. Motile bacteria have one or more flagella. Each flagellum is much simpler and consists of a single thread. The thread is made of numerous identical spherical sub-units called flagellin. Each flagellin is 40 Å in diameter. The flagellum consists of three morphological parts — (1) the basal body (2) Hook and (3) Filament. Hook



The basal body is anchored in the plasma membrane.

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(b) Pili (Fimbriae) :- These are superficial appendages (arising from the wall), which are smaller and narrower than flagella. These are composed of protein units called Pilin. These occur all over the body and are concerned with cell to cell or cell to surface attachement. These are also known as Sex pili because they help in Conjugation.

(ii) Surface Adherent :
(Capsule and slime layer) :- Some bacteria are completely enveloped by a viscous or gelatinous substance secreted by the protoplast. This envelope is known as slime layer. When the envelope becomes relatively thick and compact, it forms capsule. Chemically, capsule is made of many types of Polysaccharides of glucose but in Bacillus anthracis polypeptides are found in the capsule.

The capsule protects the cell from antibodies and desiccation. It also increases the infectivity of bacterium because of accumulation of many excretory substances of the cell.

(iii) Cell wall and Cell membrane :

(a) Cell wall : The cell wall is usually made of mucopeptide or murein, also known as peptidoglycan.

Mucopeptide is a polymer made of alternating units of N-acetyl glucosamine (NAG) and N-acetyl muramic acid (NAMA). Both have four to five amino acids. Besides, cell wall also has small quantities of carbohydrates and lipids. The cell wall of Gram +ve bacteria is characterised by the presence of teichoic acid.

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Difference in the Cell wall of Gram +ve and Gram -ve bacteria.

Gram +ve Bacteria	Gram -ve bacteria.
(1) The amount of mucopeptides is more	(1) Mucopeptide is less
(2) Cell wall rigid. — because of the presence of greater amount of peptidoglycan	(2) Cell wall elastic in nature.
(3) Teichoic acid present (anionic glycopolymers)	(3) Teichoic acid absent
(4) Low in Lipids (1-4%.)	High (11-22%.)
(5) Cell wall 100-250 A° thick	75-120 A° thick

(6) Plasma membrane: It is made up of lipo-protein as in all other organisms. Because of differentially permeable nature, it controls the passage of many solutes and solvents. It plays an important role in respiration by virtue of containing respiratory enzymes including cytochromes. Besides this, enzymes associated with lipid metabolism and those essential for synthesis of cell wall components are also present.

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(iv) Cytoplasm & Organelles

(a) Cytoplasm: It is a complex mixture of protein, lipids, minerals, nucleic acids and water. Glycogen is the major reserve food material. Cytoplasm does not show streaming movement. The cytoplasm shows following features —

- No endoplasmic reticulum
- Ribosomes scattered in the cytoplasm.
- Ribosomes are of 70s type as against 80s of eukaryotic cell.
- Mitochondria are absent.
- Chloroplast is absent. In some it is replaced by photosynthetic lamellae. Pigments such as bacteriochlorophyll, bacterioviridin occur in these lamellae. Such bacteria are able to photosynthesize and are thus autotrophic i.e.g., Rhodospirillum, Chromatium, Chlorobium etc.

(b) Karyoplasm: It is denser than the cytoplasm and is the central nuclear region consisting of diffused nucleic acid. It is termed as incipient nucleus or diffused nucleus and lacks — nuclear membrane
→ nucleolus
→ histone protein & DNA.

Genetic material, however, occurs in the form of histone free DNA. It is single large double helical structure which is circular in many bacteria. Such structure is variously called genome, genophore or nucleoid

In addition to the circular DNA extrachromosomal genetic element in the form of a piece of DNA is also present in E. coli and some related bacteria. These are called Plasmids, which are independent, self replicating units.

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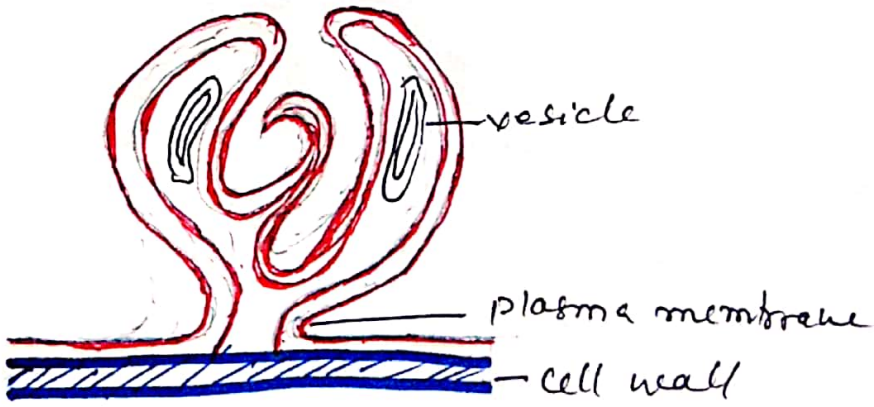
A type of plasmid, called episome, is also sometimes present. Episomes can integrate with main chromosome or DNA whereas plasmid remains independent. F-factor (fertility factor), R-plasmid (antibiotic resistant genes) are some of the types of episomes. Plasmids are useful in genetic engineering while episomes are of great importance in genetic recombination in bacteria.

© Mesosomes: These are the invagination of cell membrane which were previously thought to be equivalent to mitochondria of higher plants because of the presence of respiratory enzymes. But now a days it has been thought to play an important role in the replication of DNA and septum formation during cell division.



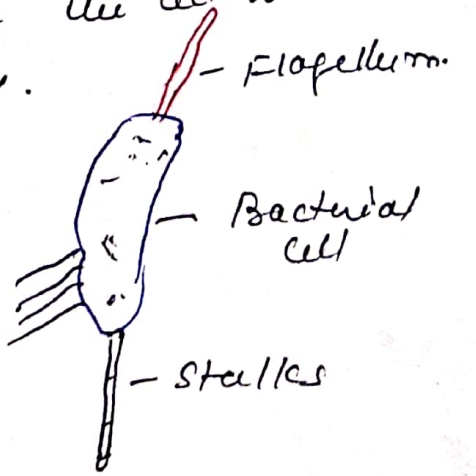
Mesosome

(V) Special Structures:

Endospore: Some bacteria like - Bacillus and Clostridium have the ability to produce a thick walled oval body (one per cell), which is highly resistant and are called endospores. Some other bacteria may produce more than one endospore per cell.

endospore formation in bacterial cell

Stalks: The stalked bacteria ~~are found~~ are found in the Alphaproteobacteria, including Caulobacter, Brevundimonas etc. They create thin extensions of the cell wall from the main cell body.



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